Device for Locking an Optical Pickup Unit of an Optical drive

FIELD OF THE INVENTION

This invention relates generally to an optical drive for writing information into an optical storage medium and/or for reading data from an optical storage medium and, more particularly, to a device for positioning an optical pickup unit of an optical drive for writing information into an optical storage medium and/or for reading data from an optical storage medium. Examples of such storage media are, for instance, CD-ROM, CD-R, CD-RW, DVD, Blu-Ray, etc. In these examples, the optical storage medium has the shape of a disc.

BACKGROUND OF THE INVENTION

As is well known in the art, an optical disc comprises at least one track which is capable of containing data written therein. The disc may be embodied so as to be a read-only disc: the disc is manufactured with data recorded in the track, and this data can only be read from the disc. However, writeable optical discs allowing a user to record data on a disc are also known; in this case, a disc will normally be manufactured as a blank disc, i.e. a disc having a track structure but without data recorded within the track.

Similarly, optical disc drives may be designed as read-only devices, i.e. devices only capable of reading information from a recorded disc. However, optical disc drives may also be designed for writing information into the track of a recordable disc. In all cases, however, an optical disc drive comprises means for receiving an optical disc and for rotating the optical disc at a predetermined rotational speed. The optical disc drive further comprises an optical head or optical pickup unit (OPU), comprising a light beam generator, typically a laser, for directing a laser beam towards the surface of a rotating disc, for receiving the reflected beam reflected by the disc, and for converting the received reflected beam into an electrical signal.

Thus, an optical pickup unit comprises a light beam generator, an optical system for directing the light beam towards the optical disc, a photo-detector for converting light into an electrical signal, and an optical system for receiving reflected light and for directing this reflected light towards the photo-detector. The optical system is capable of focusing the light beam on the track of the optical disc, and is further capable of focusing the reflected light beam on the photo-detector. The optical system is displaceable along the optical axis (z-direction) in order to be able to compensate for variations in optical path length. A servo system associated with this optical lens system is adapted to maintain the required focusing.

A problem with optical pickups is that the photo-detector must be positioned very accurately with respect to the light beam. The tolerance for the position of the photo-detector in the z-direction is of the order of around 100 μm. The tolerance in directions perpendicular to the z-direction (x-direction: radial direction; y-direction: track direction) is of the order of 10 μm. However, it is very difficult to guarantee that this positioning accuracy be maintained during the lifetime of the optical pickup, bearing in mind that the optical pickup may suffer from non-operational, mechanical shock or impact, caused by, for example, transportation or carriage of the optical drive, as a result of which the OPU may be slammed against the optical drive mechanism, and damaged.

Currently, a piece of cardboard or the like is added to the optical drive mechanism during packaging for transportation, so as to help restrict OPU movements during transportation. However, this cardboard will be permanently removed from the mechanism, once it has been installed in the console, such that OPU movement will no longer be restricted and any high impact at console level can also damage the OPU.

As explained above, the OPU is displaceable along the optical axis (z-direction) in order to be able to compensate for variations in optical path length. A servo system associated with this optical lens system is adapted to maintain the required focusing. Such a servo system generally comprises a stepper motor having a lead screw communicably coupled to an OPU follower. The OPU is attached to the follower, such that displacement of the OPU follower due to operation of the stepper motor causes corresponding displacement of the OPU, as required. However, any mechanical shock or impact applied to the optical drive can also cause damage to the stepper motor due to excessive force created by resultant OPU acceleration. Thus, any high impact at console level can damage the OPU and sledge motor.

SUMMARY OF THE INVENTION

We have now devised an improved arrangement, and it is an object of the present invention to provide a device for positioning an optical pickup unit of an optical drive in a specific drive position so as to prevent it from knocking against the respective optical drive mechanism and also to protect the stepper motor during impact or shock applied thereto during, for example, transportation or carriage of a respective device.

In accordance with the present invention, there is provided a device for positioning an optical pickup unit of an optical drive in a predetermined drive position, said device comprising a linear drive motor and a follower coupled to said optical pickup unit and

cooperatively engaged with said motor, such that operation of said motor causes linear movement of said follower and optical pickup unit during normal operation, said device comprising a stop member arranged and configured such that during normal operation of said optical drive, movement of said follower is permitted by said stop member, the device further comprising locking means for causing movement of said follower relative to said stop member at said predetermined drive position to a locked position in which movement thereof is restricted or prevented by said stop member.

In an embodiment of the invention, the motor comprises an elongate lead screw having a spiral groove defining a thread along at least a portion of its length, the follower comprising at least one projection which engages with the groove, whereby operation of the motor causes rotation of the lead screw and corresponding linear movement of the follower. In an embodiment of the invention, the follower comprises at least two projections which engage with two respective longitudinally spaced portions of said spiral groove.

Beneficially, movement of said follower to said locked position is effected by linear movement of the follower from a first position to a second, locked position. Such linear movement may be effected manually or by operation of the motor to cause corresponding rotation of the lead screw. In an embodiment of the invention, the lead screw is provided with at least one intermediate groove in a body portion of the lead screw between two adjacent, longitudinally spaced portions of the spiral groove defining the thread of said lead screw, the at least one projection being caused to engage with the intermediate groove so as to effect the locked position. In the case where the follower comprises two projections, the lead screw comprises two respective intermediate grooves with which said two projections are caused to engage to effect the locking position.

Thus, by locking the OPU in the locked position, it is prevented from knocking against the mechanism and, in addition, the linear drive motor, which is for example a stepping motor, is protected.

In an embodiment of the invention, the motor is mounted on a bracket having a base plate, the stop member projecting upwardly from the plane of the base plate. The stop member may be formed integrally with the base plate. The bracket may comprise an end wall spaced from the stop member, such that in the locked position, the follower is trapped between the end wall and the stop member.

In an embodiment of the invention, the locking means is arranged such that movement of the follower relative to the stop member in order to effect said locked position

is in a direction substantially perpendicular to the direction of linear movement of the follower during normal operation.

The present invention also extends to an optical drive including such a positioning device.

These and other aspects of the present invention will be apparent from, and elucidated with reference to, the embodiment described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1a is a schematic plan view of an optical drive mechanism including a positioning device according to an exemplary embodiment of the present invention;

Figure 1b is a schematic perspective view of the mechanism of Figure 1a;

Figure 2 is a perspective side view of a motor unit for use in the mechanism of Figure 1a;

Figure 3a is a schematic plan view of the mechanism of Figure 1a, when the follower and OPU are moving to the "home" position;

Figure 3b is a schematic perspective view of the mechanism of Figure 2a;

Figure 4a is a schematic plan view of the mechanism of Figure 1a, when the follower is locked in the "home" position; and

Figure 4b is a schematic perspective view of the mechanism of Figure 4a.

DETAILED DESCRIPTION OF THE INVENTION

It is an object of the present invention to provide an improved arrangement in which the optical pickup unit of an optical drive can be manually or electrically locked in a specific drive position as required.

Referring in the first instance to Figures 1a and 1b of the drawings, a positioning device according to an exemplary embodiment of the present invention comprises an optical pickup unit OPU 10 mounted on a follower mechanism 12 which is communicably coupled to the lead screw 14 of a stepper motor 16 by means of follower teeth 18, which engage within the grooves 20 defining the thread of the lead screw 14. As will be apparent to a person skilled in the art, the lead screw 14 is coupled to the rotor (not shown) of the motor 16, such that operation of the motor 16 causes the lead screw 14 to rotate, which is translated into linear movement of the follower 12 and OPU 10 along the length of the lead screw 14.

Thus, in the example shown, rotation of the stepper motor in a counter-clockwise direction (arrow B) is translated into linear movement of the follower and OPU in the direction indicated by the arrow A, which direction will hereinafter be referred to as the "homing direction".

Referring to Figure 2 of the drawings, the motor 16 is mounted on an elongate bracket 22 having a base plate 23 and an end wall 24 perpendicular thereto, the lead screw 14 extending along the length of the bracket 22 from the motor 16 to the end wall 24, as shown. The bracket 22 is provided with a stop member 26 near the end wall 24, the stop member 26 projecting upwardly from the plane of the base plate 23, substantially at right angles thereto. In this exemplary embodiment, the stop member 26 is formed integrally with the base plate 23, so as to define a substantially L-shaped structure, but this is not essential. The lead screw 14 is further provided with two intermediate grooves 28a, 28b in two respective adjacent body portions defined by the thread of the lead screw 14, as shown.

Referring now to Figures 3a and 3b of the drawings, in order to lock the OPU 10, for transportation or carriage of the optical drive mechanism of which it is a part, the OPU 10 must return to a so-called "home position". In order to achieve this, the motor is operated in the counter-clockwise direction (arrow B) by application of electrical pulses, so as to cause movement of the follower 12 and the OPU 10 mounted thereon in the homing direction (arrow A), until the follower teeth 18 are engaged in the last two adjacent grooves 20 defined by the thread of the lead screw 14. When the follower 12 makes contact with the end wall 24 of the motor bracket 22, the OPU 10 is considered to be in the "home position", as illustrated in Figures 3a and 3b of the drawings. The above-described homing procedure ends without any mechanical slippage between the follower and lead screw pitch. This can be achieved by lowering the current amplitude to the motor during the homing period. It will be appreciated that, because of the shape of the follower 12 and its position relative to the motor bracket 22, as well as the depth of the grooves 20 defined by the thread of the lead screw 14, during normal operation, the follower 12 is free to pass the stop member 26 projecting upwardly from the base plate 23 of the bracket 22 (see Figure 3b), i.e. when the follower 12 is in a normal position relative to the lead screw 14, it passes over the stop member 26, and causes no obstruction to the sledge system.

Referring to Figures 4a and 4b once the follower and OPU are in the home position, a "lock" command may be issued from the console (in response to a command from the user). Such a command will cause the motor to continue to rotate in the anti-clockwise direction for a further half revolution so as to force the follower teeth 18 into the intermediate grooves

28a, 28b in the lead screw 14. It will be appreciated by a person skilled in the art that it is relatively easy to control the angular position of the stepping motor by applying the correct step sizes. The current applied to the motor needs to be higher than that used to effect normal operation in order to provide the level of force required to push the follower teeth 18 into the intermediate grooves 28a, 28b. In view of the fact that the depth of the intermediate grooves 28a, 28b is less than that of the grooves 20 defined by the thread of the lead screw 14, the follower 12 is pushed in the direction of the OPU 10, such that in its new position it is locked by the stop member 26, as illustrated in Figure 4b of the drawings. In summary, therefore, in order to lock the OPU in the home position, the OPU follower is pushed towards the OPU by the intermediate grooves in the motor lead screw, such that the new follower position causes it to be locked by the stop member projecting upwardly from the motor bracket.

In order to unlock the OPU 10, the motor may be caused to continue to rotate in the anti-clockwise direction for a further half revolution, so as to cause the follower teeth 18 to return to their normal position within the grooves 20 defined by the thread of the lead screw 14, thereby causing the follower 12 to return to its normal position relative to the motor bracket 22 such that its movement is not restricted by the stop member 26.

Thus the present invention provides a mechanism whereby the OPU can be locked in any non-operational situation, thereby reducing the risk of occurrence of failure due to impact or shock. The inclusion of cardboard during the packaging process can be eliminated, and one of the main advantages of the exemplary embodiment of the present invention described above is that the OPU can be locked and unlocked by electrically controlling the stepping motor, i.e. by applying appropriate current pulses to the motor, although it will be appreciated that in an alternative embodiment, the OPU locking procedure can be performed manually by hand.

In its simplest configuration, an exemplary embodiment of the present invention can be achieved by adding two new features to the stepping motor of a known arrangement, namely the intermediate grooves in the motor lead screw and the stop member in or on the motor bracket. In some cases, it may be required to consider new dimensions for the follower, such that it is able to pass the stop member during normal operation, and an additional algorithm may be required within the control system to perform the lock/unlock procedure, if this is required to be performed by electrical control of the stepping motor angular position.

An embodiment of the present invention has been described above by way of example only, and it will be apparent to a person skilled in the art that modifications and variations

can be made to the described embodiment without departing from the scope of the invention as defined by the appended claims. Further, in the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The term "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The terms "a" or "an" does not exclude a plurality. The invention can be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In a device claim enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that measures are recited in mutually different independent claims does not indicate that a combination of these measures cannot be used to advantage.